Planting material : what strategy for planters ?

DxP seed is not only DxP seed

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Abstract

For a tropical plant, the oil palm commodity chain includes the peculiarity of possessing a major seed production sector for reasons that are primarily genetic.
Planters are always concerned about the reliability and value of the material they plant. Most oil palm plantations (around 70%) belong to large agroindustrial enterprises, but family smallholdings are also developing strongly and are in the majority in numerous countries. However, access to seeds and to information on seeds is not organized in the same way for agro-industries as for smallholders, especially if the latter are in isolated locations. In fact, it is difficult to organize seed distribution to smallholders, and very often they will depend on agro-industry strategy or middlemen networks for their own plantation.
Another peculiarity of the oil palm seed market is, despite state or public organization attempts to organize the market, the virtual total absence of guarantees for buyers. It is difficult, if not impossible, to evaluate the quality of the research conducted by breeders.
Have commercial seeds, based on scientific criteria, such as yield components, resistance to diseases, to drought, to altitude, to low temperatures, been really developed on these criteria with well-defined and adapted experimental designs?
In addition, the seed production strategies, necessary for transferring genetic progress observed in research stations into the commercial seeds, are not all reliable. And, last but not least, the technical quality of production can lead to a not inconsiderable percentage of weak seeds due to uncontrolled pollen contamination.
The only guarantee today comes from the relationships of confidence established year after year between breeders/distributors and growers. In this respect, the initial strategy for agro-industry is very often to diversify supply sources in order to guarantee their plantations an "average" value. In a second step, these groups almost always aim to become seed producers themselves. To that end, they can either link-up with breeders to acquire production licences, or if they are seeking greater independence they may attempt to procure parent material and become breeders in their own right. In either case, they must take on a major risk of ending up with a planting material that might not perform well, as the different materials available on the market display substantial

production differences that can exceed 20%. In such a case, the very future of a major industrial group could be jeopardized.

In these fields, research can lead to some proposals: to help public institutions to define a seed certification policy, molecular biology offers some interesting prospects for certifying seed quality (contamination rates and genetic origin), and social science could develop effective communication methods towards planters.

Introduction

For a tropical plant, the oil palm has a commodity chain which includes the peculiarity of possessing a major seed production and marketing sector, for reasons that are primarily genetic (Cochard et al., 2001). This seed sector has numerous original aspects. Breeders are not only propagators, but are usually also involved in the marketing of their seeds. This organization has arisen as a result of oil palm breeding methods, the constraints associated with the nature of oil palm seeds, the opportunity offered and need to fund research and plant breeding/selection costs, and also no doubt, historically to there being no legal protection (UPOV system, plant breeder certificate, etc.) for this type of plant material.

Oil palm genetic improvement has been widely described (Gascon and de Berchoux,1964; Meunier and Gascon, 1972; Corley, 1976; Cao, 1995; Soh and Hor, 2000; Durand-Gasselin and al., 2000) And other traits directly linked to sustainable agriculture are also described (Cochard and al., 2005).

Additionally, the main oil palm seed multiplication principles have been described on numerous occasions (Jacquemard and al., 1981, Durand-Gasselin and al.,1999), and we will not go into them here, but it will be useful to refer to them for a clearer understanding.

It is a well established fact that oil palm breeding and selection is characterised by a particularly long development cycle (when compared to most other crops). This fact disadvantages growers who seek specific growth/production characteristics from their plantings, or who wish to establish seed gardens of their own.

Achieving seed germination is difficult and requires lengthy treatments and specialised installations. Consequently, end-users need to procure germinated seeds originating from established seed production centres, or buy seedlings from prenurseries or nurseries. This restriction greatly influences seed distribution and the role of the different stakeholders in the seed commodity chain.

Oil palm selection, seed production and distribution naturally began with the first plantations at the beginning of the 20th century. However, it was only once it had been discovered how the “sh” gene functioned, which controls shell thickness (Durand-Gasselin and al., 2002)), and it became economically advantageous to produce "tenera" seeds derived from exclusively "dura x pisifera" crosses, that a true seed market developed. In this way, seed producers benefited from dual protection. Firstly, producing "dura x pisifera" seeds requires substantial technical know-how and has to be impeccably implemented; secondly, because seeds from commercial plantations cannot

be used to set up other plantations, otherwise more than 2/3 of yield potential is lost (Cochard and al., 2001).

Another peculiarity of the oil palm seed market is the virtual total absence of guarantees for buyers as to the identity of the germplasm offered. Yet only a plant arising from a controlled "dura x pisifera" cross between parents from the latest breeding programmes can guarantee a given level of performance. In this respect, a high level of confidence between the producer and the buyer is of paramount importance.

It therefore appears important to establish an appropriate certification system (cost, reliability) entrusted to a public or private organization, which would apply standards approved by the partners (seed producers, nurserymen, distributors, growers, etc.).

Most oil palm plantations (around 70%) belong to large agroindustrial enterprises, but family smallholdings are also developing strongly and are in the majority in numerous countries. However, access to seeds is not organized in the same way for agroindustries as for smallholders, especially if the latter are isolated.

This article describes the difficulties encountered by different stakeholders in the commodity chain, in the production, distribution and procurement of seeds, bearing in mind that many stakeholders play several roles.

1 Seed quality

Seed quality is one of the essential points that guarantee the economic success of plantations (RSPO, 2004). It is of crucial importance to growers.
This quality is the cumulated outcome of complementary approaches:

- a genetic improvement programme that lead to constant and regular genetic progress
- a seed production strategy that incorporates fully this genetic progress;
- lastly, the strictness with which this technical know-how is applied to produce seeds.

1.1 The quality of genetic improvement programmes

1.1.1 Variety creation strategies

A farmer has no access, for the moment, to a public or professional organization possessing reliable information on the production potential, or on the resistance of the various planting materials to certain diseases, of seeds provided on the market. It is of course difficult, if not impossible, for him to judge the quality of a breeding programme. Breeders and seed producers with very different resources and capacities can be found on this market. Only a few have been able to develop long-running programmes that lead to regular genetic progress; but how can a farmer judge that, and on the other hand, how can a breeder publicize his results?

Of course, growers may want to compare the different materials available on the market. Assuming that they can carry out comparative trials properly from a technical point of view (which is not that easy), and they conscientiously record yields and estimate bunch oil contents,

growers will only obtain valid answers after a dozen years of observations at the earliest. In the meantime, breeders will have proposed new varieties to the market, and it will be easy for them to praise their new qualities forgetting the situation 12 or 15 year ago.

Some materials may have had outstanding characteristics at one time, but were inadequately developed thereafter. This was the case with the "Avros"[3] origin, for example (Rajanaidu and Jalani, 1995). That material was widely used in Malaysia, but its genetic base remained too narrow to enable any further notable genetic progress to be made. Some seed producers have given up the production of this type of seed, but others still continue.

In a perennial plant like the oil palm, it is not easy to reconcile long-term progress based on the exploitation of a broad genetic base, with variety creation that, conversely, seeks to circumscribe limited genetic variability.

In addition, the production levels claimed by breeders cannot validly guide growers' choices, even though the observation methods used are more or less the same. Indeed, actual productivity is extremely dependent upon environmental and agricultural conditions, whilst extraction rates can vary in line with harvesting criteria and the age of the palms at the time the observations are made. Lastly, some breeders try to give values similar to industrial conditions, whilst others settle for raw data, or even worst, extrapolation of individual palm results, observed on experimental stations: raw data differs from industrial conditions by almost 20%, but the difference is far greater from an individual palm result!

1.1.2 Selection criteria

Of course, the main selection criteria are productivity-related criteria (FFB production and extraction rate), but it is possible to find seeds on the market that have been selected for other "secondary" criteria and those secondary criteria may sometimes become decisive in some regions.

For example, in Africa, resistance to vascular wilt is an important criterion and several breeders offer resistant planting material. But here again, it is difficult for growers to compare and judge, because they do not know how important is the fusarium strains used to carry out the screening tests, or the selection pressure applied. They do not know either whether resistance was tested directly on commercial material or simply on related families, etc. For growers, the differences in resistance levels will only become clear 10 to 15 years after planting, and by then it will be too late!

Most growers are very attentive to the vertical growth rate of the materials they plant. Vertical growth is a very visible criterion that differs substantially depending on genetic origins, some of which have their own "reputation": for instance, "Avros" is known for being very tall and "La Mé" for being among the shortest materials. However, it is difficult to predict the height of materials of "Yangambi" or "Nifor" origin, as they are variable for this trait.

Climatic conditions, even short drought periods (2 to 3 months), greatly affect oil palm yields. Most of the breeders are not able to test their material under different environmental conditions. How can drought resistance be characterized? Under average drought conditions, production

stability together with production level will be sought-after. But developing a selection programme based on this criterion needs a long observation period to be able to judge stability. In very dry marginal conditions, the aim might also be an ability to survive, but it is also necessary that such survival does not depend on low or zero production.

Lastly, tolerance to the height above sea level, or to low temperatures, do not generally have any true scientific basis but continue to rely on using populations that originate from those particular regions.

Once again, for such “secondary” characteristics, growers will have considerable difficulty judging *a priori* the quality of the products offered to them.

2.1.3 Integrating genetic progress in seeds

Identifying good crosses in genetic improvement programmes is not enough; this genetic progress also needs to be incorporated as quickly as possible into seed production. In this respect, the strategies developed by breeders vary in efficiency (Soh, 1993).

It is well known among breeders that there are substantial differences for this or that caracteristic between palms of the same family. As a consequence, any strategies involving the use of parents related to a tested parent rather than the tested parent itself, lead to a 5 to 15% deviation from the genetic value of the tested parent, depending on the degree of kinship (see for example, Yong and Chan, 1995).

In the oil palm, the variance observed is primarily of additive origin. Selfing parents to produce commercial seeds by hybridizing those selfed progenies makes it possible to preserve genetic progress, considerably amplifying seed production capacities, and even selecting some traits which may slightly improve the value of the seeds produced (Jacquemard and al., 1981). It is also possible to clone the parents through tissue culture as far as the process is well mastered and doesn’t introduce unsuitable abnormality.

In some origins, there is abundant pollen production thus the selection of a small number of pisifera palms (used as male parents in seed production) is very effective for transmitting genetic progress (Rao and al., 1999). However, the more "feminine" populations, such as advanced “La Mé” or “Nigeria” populations are more difficult to use from that point of view as they do not produce much pollen naturally, and special techniques are needed to obtain sufficient pollen (Durand-Gasselin and al., 1999). Some seed producers do not give sufficient attention to that problem and allow for a lower genetic progress in their seed production process.

Lastly, few breeders describe their seed production methods or evaluate the difference between the genetic value of the commercial seeds produced and the value of the crosses selected at the research stations (Durand-Gasselin and al., 2002). In theory it is possible to prepare in advance for seed production by setting up seed gardens before the final research results are known, in which case there would be no difference in value between commercial seeds and the on-research-station results. But, the more remote the final results are, the greater the anticipation work necessary, which leads to a large quantity of pointless material being planted in seed gardens. In practice, there should be only 2 to 3 years' anticipation, and the seed gardens are used 3 to 5 years

after the final results are obtained.

Growers receive very little information on this aspect of seed garden establishment, but it would in any case be difficult for them to interpret and verify it.

1.2 Producers' technical skills

1.2.1 Guaranteeing the tenera nature of planting material

The pre-war discovery of how the Sh gene functions made it possible to produce "D x P" or "100% tenera" seeds. This considerable progress is well understood by growers who are very particular as to the degree of purity of the seeds they buy, expressed by the tenera percentage, or conversely, by the degree of dura contamination.
Most breeders "guarantee" over 99% purity of the seed they produce, but the reality of that claim can only truly be judged two to three years after planting when the palms produce identifiable fruit. For the time being, only strict technical organization and rigorous internal control enable a few breeders to establish a reputation for quality and reliability in this field year after year.
Unfortunately, particularly in periods of high demand, it is not rare to see this reputation being eroded by unscrupulous middlemen who produce “false” seed or seedlings in the name of the breeder concerned.
Although large-scale growers generally have enough information and means of contacting genuine seed producers directly, small farmers often must depend upon those middlemen for their planting requirements.

1.2.2 Controlling the nurserymen networks

Middlemen may offer germinated seeds, seedlings from prenurseries, or one-year-old material that is ready to plant out, which allows for all sorts of manipulations to take place: forged documents, reselling of a larger number of seeds or plants than the number purchased, etc. In a few rare cases, some nurserymen have gained a good reputation and are now respectably and well established.

But today, unfortunately, it is virtually impossible to test the origin of an oil palm seedling and nurserymen lacking in scruples can operate without being caught for at least two to three years. Sometimes, Governments or NGOs take part in helping to develop "approved" nurserymen. These initiatives never give perfect results, but they do have the merits of substantially improving the situation, at least as long as the projects last.

It would therefore be useful to provide growers with better guarantees, by organizing and controlling the nurserymen networks. How to achieve such a challenge is a real subject for researchers in social sciences.

2 Access to seeds

2.1 Agroindustry

All agroindustrialists have the necessary means (access to information, to banking services and forwarding agents, substantial capital resources) to procure seeds directly from large-scale producers, either in the country itself, or by importing when it is allowed. Certain companies even have sufficient technical know-how to carry out some or all of the operations required to break seed dormancy: in that case, they buy dry or preheated seeds, rather than germinated seeds which are much more fragile. Smallholders do not have these possibilities.

2.2 Family smallholdings

The access to improved planting material may differ completely for Family smallholders according their distance from agroindustrial complex.

2.2.1 Close to agroindustry

It is generally in the interest of agroindustry, which usually owns large palm oil mills, to propose quality seedlings to growers who will later deliver their FFB to those mills. In such cases, smallholders will have access to quality seeds or seedlings prepared by agroindustry. Nevertheless, this may result in various problems. Firstly, smallholder growers will have to pay for their plants which, even when they are offered at cost price, still amount to a substantial investment for tight family budgets. This aspect is sometimes solved by "integrated" projects, which grant an advance to growers until receipt of the harvest, but these projects are increasingly rare since the "liberalization" of the production sectors. In addition, a grower is totally dependent on the policy of agroindustry, which is free to choose whether or not to supply plants to growers, assist development projects in opening up access to funds, etc. Thus, smallholder growers are often obliged to act alone.

2.2.2 Alone or far from any agroindustry.

This is the case when a grower is beyond the sphere of agroindustrial influence, or when agroindustry does not offer any planting material or other forms of aid. If one or more seed suppliers exist in the country, or if the grower has received reliable information and transport is not expensive, it will usually be possible for the grower to procure germinated seeds and he will know how to deal with the prenursery and nursery stages. If not, or if the country is very large (Indonesia in comparison to Benin), the grower will have many difficulties in procuring seeds. He will then be at the mercy of travelling salesmen selling seeds of dubious origin, or from casual nurserymen. It is to limit such vulnerability that Governments get involved in programmes to supply seeds or seedlings to growers.

2.2.3 Through Government involvement

Very many projects to advance oil palm smallholder development have been conducted by Governments. They are always complicated to implement because they require improved

infrastructures, links with agroindustry for fruit processing, training for growers, and of course the provision of quality planting material.

Some times, for understandable political reasons, governments ask public funded research centres to supply planting materials, even if in some countries it is far from being good planting material. International projects might also have to deal with the same political constraints.
Despite this problem and although they are often disparaged, government projects generally enable the efficient distribution of quality planting material direct to growers, who would otherwise be left to their own devices. Such Government projects have a positive impact on the targeted regions concerned.

3 Strategy of the major agroindustrial groups

The major agroindustrial groups, which often exploit planted areas amounting to well over 100 000 ha, are always concerned about the reliability and value of the material they plant.

Usually the strategy they employ is to diversify supply sources in order to guarantee their plantations an "average" of available material characteristics. As experience is acquired of the various sources, choices can be made with reference to some of the individual plantation results obtained.

However, faced with a lack of objective guarantees or specific requirements from seed producers, these groups almost always aim to become seed producers themselves. To that end, they can either link up with breeders to acquire production licences, or if they are seeking greater independence, they may attempt to procure parent material and become breeders in their own right.

In either case, they must take on a major risk of ending up with a planting material that might not perform well or answer to a specific requirement, as the different materials available on the market display substantial production differences that can exceed only for CPO production 20%. In such cases, the very future of a major industrial group can be jeopardized.

4 Poorly matched supply and demand

Over the last 20 years, the seed market has seen strong fluctuations in volume. For example, annual demand in Indonesia has more than doubled in 5 years (60/70 million seeds in 2000 to almost 150 million today). Breeders have trouble adapting to such fluctuations, because even when seed gardens already exist, it takes 18 to 20 months to gear up production from them. Where seed gardens do not yet exist and have to be planted, it takes at least 7 to 8 years before they can become operational. Of course, it is always possible to reopen seed gardens that had been abandoned, but to the detriment of quality: in this case, if the old seed garden correspond to the previous generation of planting material, the potential yield drop can be of 15 % or so.

This is a breeder's choice that growers often submit to without realising exactly the potential of the materials that they are being provided.

5 What do the Growers want? Do they have a choice?

Most breeders and seed producers offer planting materials, the parentages of which were initially selected from progeny trials conducted at their own specific environmental locations. The predominant selection criteria were for yield and extraction.

Such planting materials may not be ideally suited to growers establishing plantings and smallholdings with vastly differing environmental, agricultural, managerial and financial conditions. Certain growers – and it could be added, end producers - may have specific requirements over and above the basic need for high production.

Some of the additional requirements may be:

- Palms better adapted to specific environmental conditions (drought, temperature, low insolation,...)
- Palms better adapted to specific nutrient requirements (magnesium, boron deficiency, ..)
- Resistance or tolerance to specific diseases and pests, such as ganoderma, fusarium wilt, oryctes, etc.
- Economic considerations such as; fast/slow growth, height increment, high bunch number/low weight or low bunch number/high weight, high extraction/lower bunch weight, sex ratio, CPO/PK ratio, compact palms, etc.
- Downstream or end-user requirements such as olein/stearin ratio, IV and carotene content, etc.

How much do individual breeders take these requirements into consideration when selecting parental materials, and given the historical background and long breeding cycle of the oil palm, how much **can** the breeders take these requirements into consideration in their planting material offers to the market? Clonal material will probably be a very useful tool for breeders to meet some of these requirements.

Discussion and conclusions.

Our article has focused on some major characteristics of the oil palm seed market. In short, those are:

- A lack of guarantees for growers in several respects: the quality of the research conducted by breeders, the seed production strategies necessary for transferring genetic progress, and the technical quality of production.

- In fact, the only guarantee today comes from the relationships of confidence established year after year between breeders/distributors and growers.

- Major inequalities in the access to seeds between agroindustry and smallholders, which is due to the problem of passing on reliable information to smallholders, the perishable nature of germinated seeds, and sometimes the impossibility for smallholders to gain direct access to breeders.

- Difficulty in organizing seed distribution to smallholders. This is partly due to difficulties that the profession, or a State-run organization, has in controlling middlemen networks, and partly due to the absence of any protective systems (UPOV, plant breeder certificate, etc.) that generally oblige breeders to preserve and propagate parents in their own installations.

- Lastly, middlemen lacking in scruples benefiting with virtual impunity from an open market situation, even though there are some fine examples of successful distribution via nurserymen networks (Thaïland, Benin,..). These experiences remain fragile, however.

One immediate improvement would be the development of a clearer understanding among growers of what characterizes planting material quality. This comment is equally valid for both large companies and for family smallholdings. In the first case, companies would be able to more effectively determine their strategy for access to planting material, and we have shown how much their profitability may depend on that. In the second case, returns on smallholder financial and labour investments will result in an appreciable and regular increase in income, contributing to break the vicious circle of poverty in which most find themselves.

On a world scale, what matters most is the millions of tonnes of oil, 5, 10 or perhaps more, that are not produced over a given area due to the planting of low potential materials. This concern is further compounded by the concurrent increase in land tenure pressure caused by economic demand for oil requiring expansion of planted areas.

Can research propose tools for certifying seed quality? Can it develop effective communication and distribution methods?

In this field, molecular biology offers some interesting prospects. It will be possible to verify the tenera type of seeds or nursery seedlings if genetic markers can be found that are linked to that trait. It should also be possible to judge planting material uniformity by measuring the degree of kinship between plants; but that measurement will be trickier to carry out. Lastly, breeders should be able to monitor distribution chains through molecular characterization of the plants they breed. All these tools should soon make it possible to guarantee the quality of planting material offered to growers.

Could public research develop cataloguing systems? Under strict conditions yet to be defined, new varieties produced by breeders could be assessed before their marketing is authorized. Of course, this takes time but would provide a real guarantee for growers.

It is also up to researchers to propose minimum specifications that breeders would have to respect in order to obtain official or Governmental approval. Some countries (Indonesia, Thailand, etc.) already issue such certification, which varies in strictness, to breeders located within their territory. Additionally, it ought to be possible to generalize that system through interprofessional associations in conjunction with the public authorities. At the same time, research needs to take part in improving the information provided to growers, by helping to formulate its content and by proposing more efficient means of communication.

Breeders need to better define what growers want, and assess how far individual requirements could be met given the current progression of their individual breeding programmes.

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